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Original Article

Medicinal plants used in cancer treatment: A survey conducted among traditional Ayurveda medical practitioners in Sri Lanka

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Abstract

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Majority of deaths worldwide have been caused by noncommunicable diseases, with cancer as the second leading cause. Plant-based cures have become increasingly popular because current synthetic pharmaceuticals and other medications have demonstrated severe side effects, leading to less patient compliance and treatment failure. Furthermore, for most cancer types, there is no permanent cure. Sri Lankan traditional practitioners employ natural plant remedies to treat and cure malignancies, drawing on a long history of Ayurveda treatments and ancestral wisdom. These practitioners use different extraction processes, different parts of the same plant, and different modes of administration of the same herb. This descriptive cross-sectional study identifies commonly utilized botanicals with anticancer properties by traditional ayurvedic practitioners in Sri Lanka. The snowball approach and purposive sampling were used to select medical practitioners for this study. The survey was conducted among 18 traditional ayurvedic practitioners, and from the survey, 120 plants that the practitioners used for cancer therapy were identified. Of those 120 plants, the repetitive plants were shortlisted for ten plants. The most commonly used plants identified in this survey were *Flueggea leucopyrus*, *Curcuma longa*, *Aegle marmelos*, *Abrus precatorius*, *Phyllanthus emblica*, *Zingiber officinale*, *Annona muricata*, *Aloe vera*, *Manihot esculenta*, and *Solanum melongena*. Most medicinal plants used for cancer treatment were from the family Fabaceae.

Keyword: Anticancer, Medicinal plants, Sri Lanka, Traditional medical practitioners

Introduction

Cancer is a significant health concern that contemporary medicine must cope with. In 2020, there were 19.3 million cancer cases and 10 million cancer deaths (World Health Organization, 2020a). According to the World Health Organization, cancer claims the lives of 16,691 people in Sri Lanka yearly (World Health Organization, 2020b). The annual cancer death rate in 2020 was higher than in previous years (World Health Organization, 2018). Chemotherapy, radiation, and surgery are the only three major cancer treatments available in modern medicine (Jesmin & Sarker, 2014). Modern medicine has improved efficacy and increased survival but also has unpleasant side effects. Furthermore, they do not appear to be 100% effective. As part of a new strategy, the scientific community focuses on traditional medical practice to develop a viable solution (Nurgali, Jagoe, and Abalo, 2018).

Sri Lanka has had a rich indigenous knowledge and cultural repertory related to traditional medicine for over 3000 years (de Zoysa & Palitharathne, 2008). Ayurveda, Sidda, Unani, and Desiya Chikitsa are today's four essential components of traditional medicine. The Desiya Chikitsa is the indigenous component and also apparently the oldest (Arseculeratne, 2002). Sri Lanka is a tropical country with abundant natural herbs and a great history of traditional plant-based medicine, and alternative therapy identification. Traditional ayurvedic medicine will reduce the country's healthcare burden (Jones & Liyanage, 2018). Increased attempts have been made in the last several decades to isolate bioactive chemicals extracted from herbs, which have been known for their utility in synthesizing novel medications that are less toxic and more effective against non-tumor cells than synthetic drugs (Shafi et al., 2018).

Medicinal plants have been providing essential therapeutic assistance in treating people's ailments for thousands of years. More than 60% of anticancer medications are derived from

natural ingredients (Khor et al., 2018). As a result, herbal medicines have received attention worldwide in recent years. Plant extracts have displayed many critical biological activities (Mishra, Kumar, and Pandey, 2013). Different phenolic compounds found in herbal plants and are known to contain anti-cytotoxic properties have the potential to fight against cancer rather than synthetic drugs (Turrini et al., 2018).

The importance of analyzing the scientific basis of herbal medicine for treating various ailments is growing daily, with the enhanced attention to traditional and folk medicine (Metel, 2017). Traditional medicine has its methods for obtaining beneficial components from these plants. Because they are natural, the chances of adverse effects are minimal (Sofowora et al., 2013). However, there is a significant gap in understanding between the plants employed in traditional anticancer treatments and their mode of action methods. Further, introducing traditional Sri Lankan medicine to the scientific society is challenging due to the unwillingness of the traditional Ayurveda practitioners to share their knowledge (Silva, 2016). The traditional knowledge is buried with the practitioner most of the time. Therefore, this study aims to broach the hidden traditional knowledge of Ayurvedic practitioners and present it to the modern scientific world. Further, this study aims to emphasize current scientific evidence by reviewing selected traditional medicinal plants.

Methodology

Study Area and Selection of Respondents

This survey was conducted from May to December 2019 among traditional Ayurvedic practitioners in Sri Lanka who engaged only in cancer treatment. Twenty - one registered traditional Ayurvedic practitioners were identified in cancer, cancer & balaroga, and cancer boils subcategories as per the Ayurvedic council categorization (Council, 2021). Snowball and purposive sampling techniques were used to conduct a descriptive cross-sectional study on

traditional Ayurvedic medical practitioners who practiced cancer treatments. Each practitioner was informed of the study's objectives before data collection to obtain their consent and cooperation for the survey. However, the sample size was limited to eighteen practitioners as some contacted practitioners were unwilling to share their traditional Ayurvedic knowledge for the study.

Preparation of Questionnaire

This survey was conducted by using an interviewer-administered questionnaire. Informed consent was obtained for the survey from eighteen medical practitioners. Information related to herbal plants for anticancer therapy was collected from the practitioners via a pretested questionnaire. Data was collected via a semi-structured questionnaire. The first section was designed to gather general information about the practitioners, including the practitioner's name, gender, age, experience in the profession, education level, and province/district. Other sections of the questionnaire were mainly dedicated to gather information on medicinal plants and plant parts used in cancer treatments. The part of the plant used for the medicines, effective dosages, method of administration, method of obtaining authentication of plants, extraction methods of plants were also collected. However, information on cancer remedies and particular cancer types were not collected due to the unwillingness of practitioners to disclose their family recipes. The data regarding the active components of the plant and its association with different cancers were derived through a literature survey (Table 03).

Ethical approval was obtained from the Ethics Review Committee of KIU (KIU/ERC/19/31). The collected data were tabulated and analyzed using Statistical Package for the Social Sciences software 16 to evaluate descriptive statistics of the population.

Results

From the selected sample of 18 traditional ayurvedic practitioners, the majority were from Anuradhapura 4(22.2%), Colombo 4(22.2%), and Kandy 4(22.2%) Districts.

According to the study data, 17 medical practitioners were registered Ayurveda doctors with degrees and diplomas in science. One practitioner was not registered under the Ayurvedic council but practiced traditional Ayurveda.

Among the 18 medical practitioners, 11(61.1%) medical practitioners were female. Other than cancer treatment, these practitioners practiced as general practitioners (sarwanga), treated patients for, orthopedic disorders (kadum bidum), ayurvedic surgery, diabetes, and for gynaecology disorders. These practitioners used their experience (education, clinical trials, ancestral manuscripts, Ayurveda literature books, Olam books) to authenticate the plants used for their ayurvedic treatment. None of the ayurvedic practitioners used novel techniques such as botanical authentication by a botanist.

When inquired into the treatment method used, 11(61.1%) of the practitioners were using external body treatments (skin application, panchakarma prathikarma, paththu badeema and herbal bath), and 7(38.9%) of the practitioners used internal body treatment via traditional preparations (kasaya, chuurna, guli, kalka, arishta and drugs) as cancer treatments.

When the patient assessment was inquired into, 13(72.2%) practitioners confirmed their diagnosis by observing patients' signs and symptoms, 3(16.7%) of the practitioners came to their diagnosis by discussing with the patient, 1(5.6%) used pulse assessment, and only 1(5.6%) used laboratory reports for their diagnosis.

Analysis of responses revealed details about 120 plants that are used in cancer treatment during recent times by the traditional Ayurvedic

practitioners in the survey. Among them, the majority (18 (15%)) of plants were from the family Fabaceae, followed by Apocynaceae (07(5.83%)) and Rutaceae (06 (5%)) as indicated in figure 1. According to the survey results, the plants of the Fabaceae, Apocynaceae and Rutaceae families are the most commonly used plants for cancer treatment in this report. The names of the plants used for cancer belonging to the most commonly used families are indicated in table 1.

Table 1 – Plants used for the cancer treatment belonging to the most commonly used plant families

Family	Plants
Fabaceae	<i>Erythrina variegata</i> , <i>Bauhinia tomentosa</i> , <i>Clitoria ternatea</i> , <i>Desmodium triflorum</i> , <i>Trigonella foenum</i> , <i>Vigna radiate</i> , <i>Cicer arietinum</i> , <i>Macrotyloma uniflorum</i> , <i>Bauhinia purpurea</i> , <i>Abrus precatorius</i> , <i>Cassia auriculata</i> , <i>Mucuna pruriens</i> , <i>Mimosa pudica</i> , <i>Canavalia cathartica</i> thouras, <i>Canavalia ensiformis</i> (Linn), <i>Caesalpinia sappan</i> , <i>Glycyrrhiza glabra</i> , and <i>Cassia fistula</i>
Apocynaceae	<i>Hemidesmus indicus</i> , <i>Catharanthus roseus</i> , <i>Rauwolfia serpentine</i> , <i>Rauwolfia densifolia</i> , <i>Calotropis procer</i> , <i>Dregea volubilis</i> , and <i>Nerium oleander</i>
Rutaceae	<i>Aegle marmelos</i> , <i>Citrus reticulata</i> , <i>Acronychia pedunculata</i> , <i>Limonia acidissima</i> , <i>Citrus aurantium</i> , and <i>Feronia limonia</i>

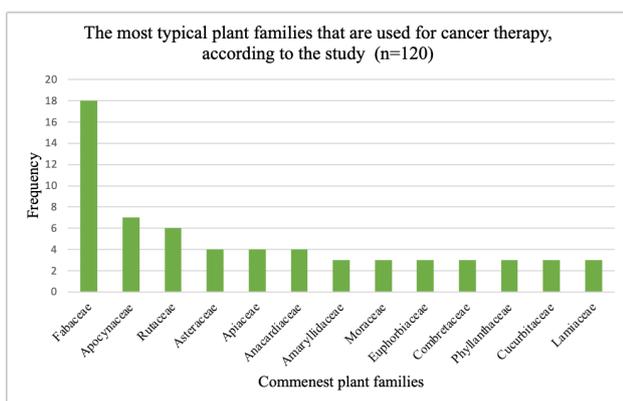


Figure 1 - The most typical plant families that are used for cancer therapy

Further, the most commonly used 10 plants among the 120 plants were selected for further review. Accordingly data gathered from the 18 medical practitioners revealed that *Flueggea leucopyrus* (n=13), *Annona muricata* (n=7), *Curcuma longa* (n=6), *Aegle marmelos* (n=4), *Abrus precatorius* (n=5), *Phyllanthus emblica* (n=5), *Zingiber officinale* (n=4), *Aloe vera* (n=4), *Manihot esculenta* (n=4), and *Solanum melongena* (n=4) were the most commonly used plants in the study (Figure 2).



A - *Aloe vera*, B - *Zingiber officinale*, C - *Curcuma longa*, D - *Annona muricata*, E - *Abrus precatorius*, F - *Phyllanthus emblica*, G - *Solanum melongena*, H - *Manihot esculenta*, I - *Flueggea leucopyrus*, J - *Aegle marmelos*

Figure 2 – The ten most commonly used plants by the 18 medical practitioners of the ten most commonly used plants, *Flueggea leucopyrus*, *Annona muricata*, *Curcuma longa* were seen to be used more commonly than others.

The part of the plant of the ten most commonly used plants is shown in table 2. According to the received data majority of the medical practitioners are using *F. leucopyrus* as the whole plant for cancer treatment (8(61.5%)), while the leaves and roots were used by 3 (23%) and 2 (15.3%) practitioners respectively. *A. muricata* was used by seven medical practitioners and the majority (5 (71.4%)) used the fruit for cancer treatment while 1(14.2%) practitioner used the leaves and 1(14.2%) practitioner used the whole plant for the treatment. When inquired about *C. longa*, all (6(100%)) the practitioners used the rhizome. *A. marmelos* was used by five medicinal practitioners, on inquiry into the parts of the plants used, fruit, roots and immature leaves were used by 2(50%), 1(25%) and 1(25%) respectively. *A. precatorius* leaves were used by 3(60%) and seeds were used by 2(30%) practitioners for the treatment of cancer. When considering *P. embellica* 2 (40%) used the dry fruit, 2 (40%) used the leaves and 1(20%) used the whole plant for treatment. *Z. officinale* rhizome was used by 3(75%) and leaves were used by 1(25%) of the medical practitioners in anticancer therapy. *Aloe vera* leaf gel was used by 3(75%) and the whole leaf was used

by 1(25%) in the treatment. *Manihot esculenta* tuber was used by 3(75%) and leaves were used by 1(25%).

Table 2 – Part of the plants used in the treatment of cancer for the most commonly used plants.

Vernacular name in Sinhalese	Scientific name	Family	Part of the plant used in the treatment by the traditional
Katupila	<i>Flueggea leucopyrus</i>	Phyllanthaceae	Leaf (n=3) Whole plant (n=8) Roots (n=2)
Katu anoda	<i>Annona muricata</i>	Annonaceae	Fruit (n=5) Leaves (n=1) Whole plant (n=1)
Kaha	<i>Curcuma longa</i>	Acoraceae	Rhizome (n=6)
Beli	<i>Aegle marmelos</i>	Rutaceae	Immature leaves (n=1) Roots (n=1) Fruit (n=2)
Olinda/ Gunja	<i>Abrus precatorius</i>	Fabaceae	Leaves (n=3) Seeds (n=2)
Nelli	<i>Phyllanthus emblica</i>	Phyllanthaceae	Dry Fruit (n=2) Leaves (n=2) whole plant (n=1)
Iguru	<i>Zingiber officinale</i>	Zingiberaceae	Rhizome (n=3) Leaves (n=1)
Komarika	<i>Aloe vera</i>	Xanthorrhoeaceae/ Aloaceae	Leaves (n=1) Leaf gel (n=3)
Manyokka	<i>Manihot esculenta</i>	Euphorbiaceae	Tubers (n=3) Leaves (n=1)
Ela Batu	<i>Solanum melongena</i>	Solanaceae	Roots (n=1) Fruit (n=3)

Following literature survey on the association between the ten most commonly used plants, their active compounds and type of cancer treatment table 3 was generated. It was revealed that Katupila both fresh and dry were used to treat liver cancer, endometrial cancer, breast cancer, prostate cancer, ovarian cancer and acute leukaemia, while *C. longa* was used in the treatment for a larger number of cancer types (table 3). Interestingly breast cancer was treated with all ten plants listed in table 3. Further, literature revealed that lung cancer was treated with *Curcuma longa*, *Aegle marmelos*, *Abrus precatorius*, *Phyllanthus emblica*, *Annona muricata* and *Aloe vera*. Only two plants *Zingiber officinale* and *Annona muricata* were found to be effective against pancreatic cancer.

Table 3 – The active compounds and the targeted cancer type for the most commonly used ten plants

No	Vernacular name in Sinhalese	Scientific name	Family	The physical nature of the plant used	Active compound/agent	Scientific claim for the targeted cancer types	References
01	Katupila	<i>Flueggea leucopyrus</i>	Phyllanthaceae	Fresh Dry	Berginin, gallic acid, quercetin, coumarin, kaempferol	<ul style="list-style-type: none"> Liver cancer Endometrial carcinoma Breast cancer Prostate cancer Ovarian cancer Acute Leukemia 	(Soysa et al., 2014) (Wijayabandara et al., 2015) (Samarakoon et al., 2014) (Deepthi et al., 2018) (Muhammed et al., 2018)
02	Kaha	<i>Curcuma longa</i>	Acoraceae	Dry	Alpha (α)- and beta (β)-asarone	<ul style="list-style-type: none"> Oral cancer Gastric cancer Glioblastoma Colorectal cancer Gastric cancer Prostate cancer Cervical cancer Lung cancer Breast cancer Neuroblastoma Lymphoma Liver cancers Lymphoma 	(Das et al., 2019) (Antony et al., 2017) (Hightgh et al., 2017) (Sreogya & Santly, 2015) (Sharma et al., 2020)
03	Beli	<i>Aegle marmelos</i>	Rutaceae	Fresh Dry	Furanocoumarin imperatorin, Marmelin, lupool, eugenol, citral, cineole and δ-limonene	<ul style="list-style-type: none"> Breast cancer Liver cancer Lung cancer Colon cancer Ovarian cancer Prostate cancer Leukemia 	(Semanisamy et al., 2019) (Akhoury et al., 2020) (Vardhini et al., 2018) (Bhatti et al., 2013) (Murthy et al., 2020) (Kumar & Bodla, 2018)

04	Olinda/ Gunja	<i>Abrus precatorius</i>	Fabaceae	Fresh Dry	Stigmasterol hemihydrate, (β-momolinolein)	<ul style="list-style-type: none"> Cervical cancer Breast cancer Cervix cancer Leukemia Ovarian cancer Prostate cancer Colon cancer Liver cancer Lung cancer Oral cancer 	(Waze-Ibrahim et al., 2019) (Okoro et al., 2019) (Sofi et al., 2018) (Pati et al., 2015) (Panda, 2013)
05	Nelli	<i>Phyllanthus emblica</i>	Phyllanthaceae	Fresh Dry	Ellagic acid, Corilagin, Pyrogallol, Catechollic acid, Gallic acid, Quercetin	<ul style="list-style-type: none"> Cervical cancer Lung cancer Colon cancer Liver cancer Ovarian cancer Colorectal cancers Breast cancer 	(Kuruppu et al., 2019) (Zhao et al., 2015) (Mahata et al., 2013) (Asmitha et al., 2020) (VERMA et al., 2012) (Ngankiidechakul et al., 2010) (Zhao et al., 2016)
06	Iguru	<i>Zingiber officinale</i>	Zingiberaceae	Dry Fresh	Gingerols, which are converted to shogaols, paradols and zingerone	<ul style="list-style-type: none"> Colorectal cancer Breast cancer Liver cancer Cervical cancers Pancreatic cancer Gastrointestinal cancer 	(Kuruppu et al., 2019) (Ansari et al., 2016) (Park et al., 2014) (Akimoto et al., 2015) (Prakash et al., 2016) (S. Prasad & Tyagi, 2015)
07	Katu anoda	<i>Annona muricata</i>	Annonaceae	Fresh Dry	Acetogenins	<ul style="list-style-type: none"> Breast cancer Colorectal cancer Skin cancer Head and neck cancers Lung cancer Liver cancer Pancreatic cancer Prostate cancer Bone cancer Ovarian cancer Cervical cancer Leukemia 	(S. K. Prasad et al., 2019) (Cassé, 2018) (Agra et al., 2018)
08	Komarka	<i>Aloe vera</i>	Xanthorrhoeaceae/ Aloaceae	Fresh Dry	Aloe-emodin	<ul style="list-style-type: none"> Skin cancer Liver cancer Leukemia Breast cancer Gastric cancer Lung cancer Oral cancer Prostate cancer Bladder cancer Cervical cancer Colon cancer Nasopharyngeal cancer Oral cancer Ovarian cancer 	(Sanders et al., 2018) (Candiken et al., 2017) (Shahabi et al., 2015) (Yonehara et al., 2015)
09	Manyokka	<i>Manihot esculenta</i>	Euphorbiaceae	Fresh	Linamarin, β-carotene, vitamin C, and fiber	<ul style="list-style-type: none"> Leukemia Breast cancer Colon cancer 	(Diana et al., 2018) (Mustariche et al., 2020) (Nisa et al., 2015) (Arafat et al., 2016)
10	Ela Batu	<i>Solanum melongena</i>	Solanaceae	Fresh Dry	Glycoalkaloids (solasanine, solasodine and solanargine), steroidal glycosides (β-sitosterol-3-O-β-D-glucoside and poriferasterol-3-O-β-D-glucoside)	<ul style="list-style-type: none"> Liver cancer Colon cancer Larynx cancer Breast cancer Cervix cancer Liver cancer Skin cancer 	(Fekry et al., 2019) (Sarah & Mishbahuddin, 2018) (Shibana et al., 2013)

Discussion

As revealed by the current study majority of the medical practitioners treating cancer, cancer & balaroga, and cancer boils were females. In keeping with those study findings, the Basement Report of the Institution Frame of Private Sector of Western Medicine and State Indigenous Medicine Sector 2017 reports that most consultants/specialists are females, working full-time and part-time in Sri Lanka. Further compared to males the distribution of female consultants in the state indigenous medicine sector is 74% (Ministry of Health and Indigenous Medicine, 2017). Comparable to this study other studies in Mali (Nordeng et al., 2013), Indonesia (Peltzer & Pengpid, 2019) and Canada (Ijaz et al., 2021) have shown a higher number of traditional female practitioners.

Rather than relying on cutting-edge technology, Sri Lankans Ayurveda and traditional medical practitioners continue to draw on their expertise to manage cancer patients by consulting Olam books, ancestral manuscripts, and Ayurveda literature books as found in this study. Similarly, analysis into global ayurveda practices has seen a staling progression due to predominant

heritage, pride and past glory base perception among traditional ayurvedic practitioners and the reluctance to practice evidence based medicine (Patwardhan, 2014).

According to the study data, 17 medical practitioners were registered Ayurveda doctors with degrees and diplomas in science. One practitioner was not registered under the Ayurvedic council but practiced traditional Ayurveda for over two decades passing down generations. It is evident that many ayurvedic practitioners practice without registrations not only in Sri Lanka but globally (Welch, 2008).

Identifying the correct medicinal plants that go into preparing a medicine is essential in the ayurvedic medicinal industry (Jayanka & Fernando, 2020). Alarmingly it was noticed that the study population selected in this report practiced using plants based on traditional experience and did not resort to additional authentication or scientific method in identifying plants.

According to this report, most plants used by traditional ayurvedic practitioners for cancer treatment are from the family Fabaceae. Herbs from the Fabaceae family have traditionally been used to treat various ailments. Isoflavones, lectins, saponins, and phenolic compounds are among the phytochemicals found in the Fabaceae family. Sebastian and Gomathi report that the phytochemicals present in Fabaceae family act as antioxidants and are used for treatment and prevention of cancer (Sebastian & Gomathi, 2020). Further the family Fabaceae is well known for its anticancer property and has been extensively reviewed by the scientific community (Oliveira et al., 2022). According to Sharma et al., those who consume plants of the family Fabaceae as a staple diet have lower cancer mortality (Sharma et al., 2017).

As reported in the current study, *Flueggea leucopyrus* has been used extensively in treatment of cancer in Sri Lanka (Hettihewa et al., 2015). Current study determined that the

practitioners used whole plant, roots and leaves. Bulugahapitiya et al., 2020 has reported that the leaves of the *F. leucopyrus* plant contains a Bergenin isomer which is responsible for the anticancer activity (Bulugahapitiya et al., 2020). Anticancer activity also has been detected for the bark and aerial parts of this plant (Bulugahapitiya et al., 2020). Further report suggest that bergenin could be used to develop more potent galectin-3 inhibitors which is a anticancer mechanism (Jayakody et al., 2018, Stegmayr et al., 2019). As determine by the literature survey done in this report the aerial parts of the *F. leucopyrus* is effective against the breast cancers (Mendis et al., 2015) and endometrial carcinoma (Samarakoon et al., 2014). Further the bark of *F. leucopyrus* has been identified to be effective against ovarian carcinoma (Hettihewa et al., 2015)

Annona muricata was the second most commonest plant (fruits, leaves and whole plant) used for cancer therapy in this study group. Other studies have shown that leaves of *Annona muricata* have potent anticancer activity (Naik et al., 2021) and also has been used in breast cancers (Gavamukulya et al., 2014). The most important phychemicals of *A. muricata* are alkaloids, phenols and acetogenins (Coria-Téllez et al., 2018). According to Rady et al, in Africa and South America several parts of the plant including the bark, fruits, leaves, pericarp, seeds, and roots, have been used to treat a variety of cancers breast, prostate, colorectal, lung, leukemia, renal, pancreatic, hepatic, oral, melanoma, cervical, and ovarian cancers (Rady et al., 2018).

Studies have found that *C. longa* is a commonly used anticancer plant as determined in this study. The major ingredient in *C. longa* is curcumin. It is reported to inhibit various cancers such as colon, hepatocellular, breast, renal, prostate cancers, T cell leukemia, and B cell lymphoma (Aggarwal & Chandra Bharti, 2003).

Several studies have highlighted the importance of plant extracts as anticancer agents in Breast cancer (Levitsky & Dembitsky, 2015; Mitra &

Dash, 2018). Interestingly the current study identified that all the ten commonest plants have been used as breast cancer therapy. This highlights the importance of plant extracts as a future product to fight the battle against cancer. It further highlights the importance of proper authentication of the plant and in practicing evidence-based medicine.

Conclusion

The study concludes that *Flueggea leucopyrus*, *Curcuma longa*, *Aegle marmelos*, *Abrus precatorius*, *Phyllanthus emblica*, *Zingiber officinale*, *Annona muricata*, *Aloe vera*, *Manihot esculenta*, and *Solanum melongena* are commonly used in cancer treatment.

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